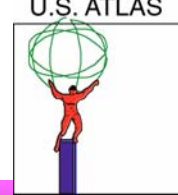


Construction, Installation, Commissioning and ATLAS Upgrade

Hong Ma

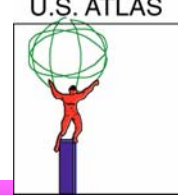
**DOE Annual HEP Program Review
Brookhaven National Laboratory
17 April 2007**

BNL's Role in ATLAS



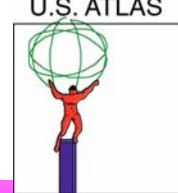
- **Overview of BNL Role in ATLAS (plenary)** **H. Gordon**
 - ◆ U.S. ATLAS Analysis Support Center
 - ◆ BNL Role in US ATLAS Management
 - ◆ BNL Role in Construction & Research program
- **Overview of ATLAS Computing Facility.(plenary)** **M. Ernst**
 - ◆ Tier I Center, Grid computing
- **Construction/Installation/Commissioning/
ATLAS Upgrade** **H. Ma**
 - ◆ **Construction / Installation / Commissioning:**
 - Liquid argon calorimeter
 - Cathode strip chambers (Muon system)
 - ATLAS Technical Coordination
 - ◆ **ATLAS upgrade**
 - Upgrade Project Office; Tracking; LAr; Muon
- **ATLAS Software and detector performance** **S.Rajagopalan**
 - ◆ Core Software, Analysis Tools,
- **Physics** **K. Cranmer**
 - ◆ Physics Analysis
 - ◆ Plus Parallel Session III (Parallel Theory)
Paige/Davoudiasl/Jackson

General Approach



- Construction responsibility matched to unique technical expertise and capability at BNL.
- Physics & Instrumentation Division were pioneers in R&D for both LAr calorimeter and cathode strip chambers.
- Contribution to the analysis is built on: detector expertise in the calorimeter and muon systems and Core software strength.
- ATLAS upgrade concentrates on the tracking system and Calorimeter readout where we take advantage of unique developments. Major role in overall optimization via Upgrade PO activities.

Cryostat & Feedthroughs



- ◆ Barrel cryostat
- ◆ Feedthroughs

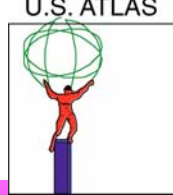
J. Sondericker, D. Lissauer
T. Muller, B. Hackenburg

- Barrel cryostat production started March '99 at KHI.
Arrived at CERN and accepted by ATLAS by Aug '01.
- Feedthrough production factory and test facility set up at BNL.
- All 64 FTs (100K Channels!) installed and fully checked in March '02.
- EM Calorimeter installed in the Cryostat in '03 and Cold vessel was welded shut by end of '03.
- Cool down on surface April '04
cold test completed by Sept '04.
- In Experimental Hall October '04.
- Moved to final position August '05.



Filled with LAr in June 06,
empty and refill in July 2006
Cosmic data taking since Aug 2006

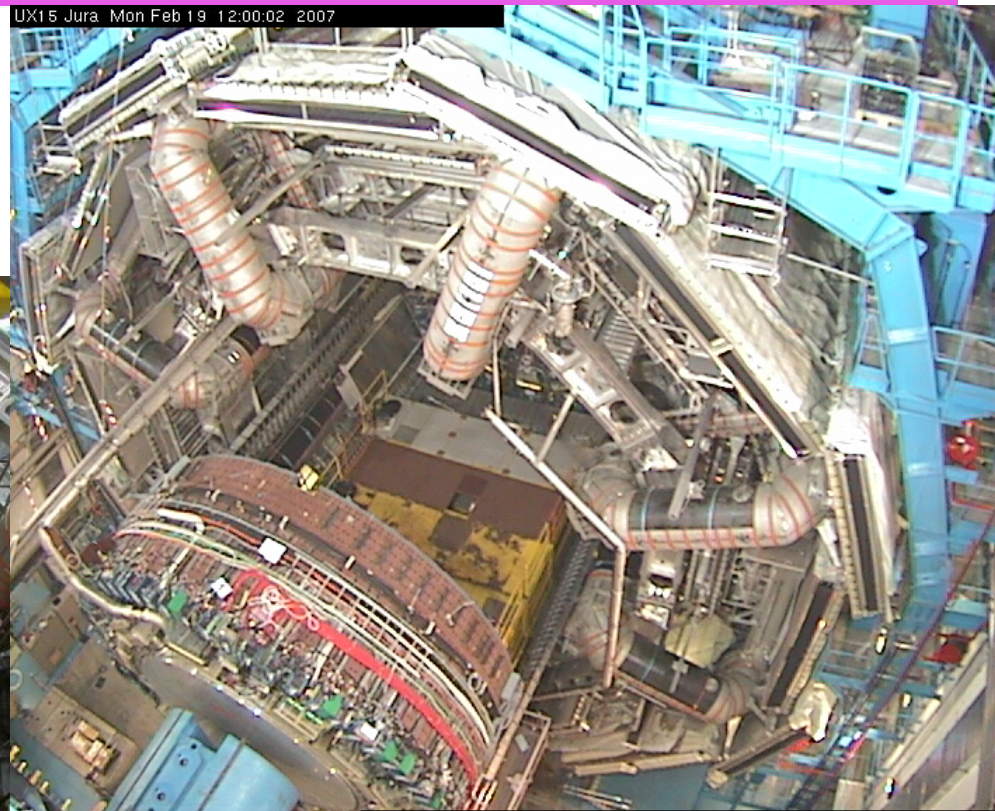
Barrel and Endcap



Barrel Calorimeter
in Final Position.

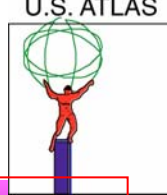


UX15 Jura Mon Feb 19 12:00:02 2007



Endcap-A Calorimeter
In Open Position.

LAr Cryogenics



- **Persons Responsible:** J. Sondericker , D. Lissauer
- **Responsibility:** Refrigerator, LN₂ Dewar, Quality Meters, Control System

- **Contract Air Liquide for:**
 - Refrigerator , Nitrogen Dewar
 - Installed and accepted at CERN.
- **Quality Meter (Built at BNL)**
 - Installed & accepted at CERN.
- **Control system**
 - Functional analysis and programming for N₂ control.
- **System acceptance tests**
 - Completed in '05.
- **System commissioning**
 - Completed in '06.

- LAr Dewar filled in March '06.
- Barrel fill complete in June '06
- Endcap-A filled with LAr in Mar '07
- Endcap-C cooldown in April '07



- **Electrodes**
- **Motherboards (cold elec.)**
- **System crate: on detector electronics**

Preamps

Monitoring Board

Warm cables

Base-plane – analog trigger sums

Pedestal and Crate

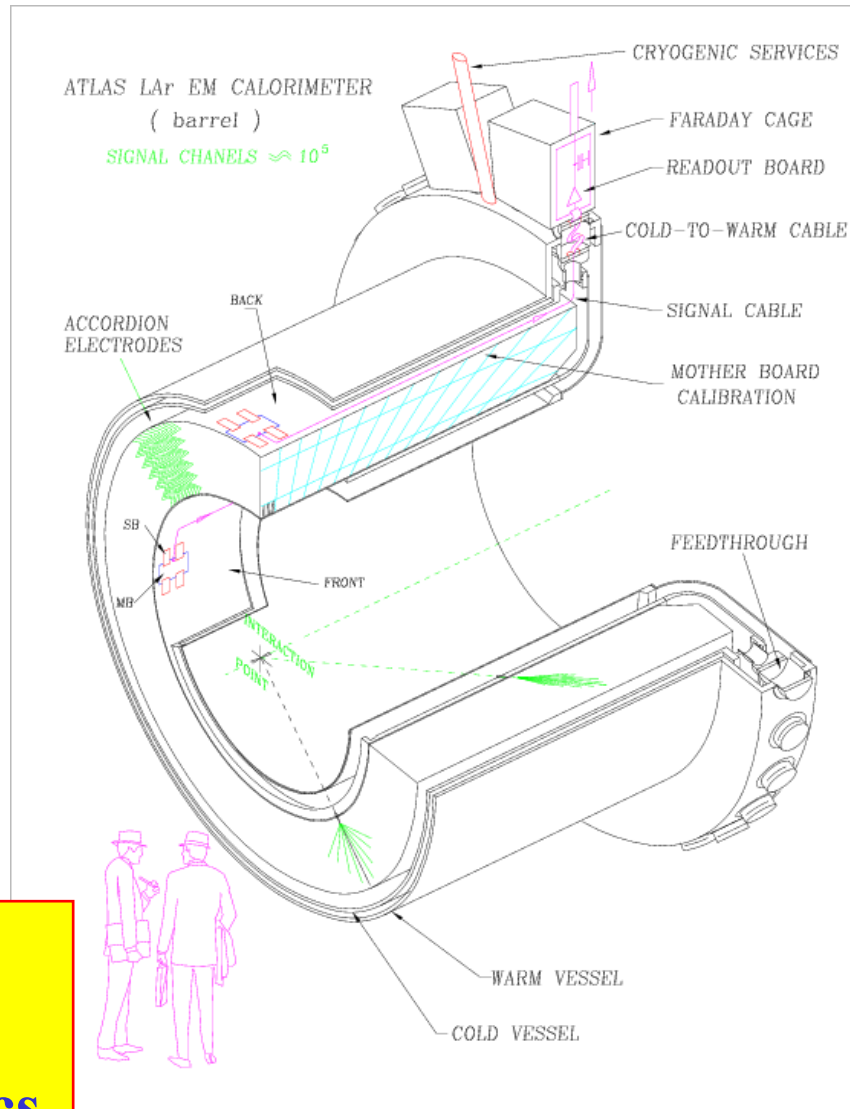
Cooling system

FEB Final Assembly and testing

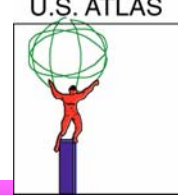
Rad-hard power supply

- **System Tests**

- **All production completed**
- **Installation in progress**
- **Commission of frontend electronics**



Front-End System Test

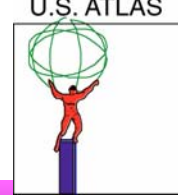


- **Persons responsible:** F. Lanni, H. Chen; S. Rescia, D. Makowiecki
- **Responsibility:** Full front-end electronics system integration
- **FE system test at BNL:**
 - Only such system outside CERN
 - Full readout chain
 - Test for dynamic range, linearity, coherent noise, crosstalk.
 - Used for FEB production tests
 - Long term system stability test
- **Maintained as a test facility for LAr Frontend electronics**
 - It was used to validate the LVPS modification



BNL System Test Lab.

Crate Assembly & Integration



- ◆ **Persons Responsible:** F. Lanni, T. Muller, S. Norton, D. Damazio, H. Chen
- ◆ **Responsibility:** Barrel & EC Front-end electronics crates

- ◆ **Warm cables, Pedestal and Base-planes**

- Production & Installation completed.

- ◆ **System Crates & Cooling system.**

- Production Completed.
 - Barrel Installation Completed.
 - Endcap installation Completed

- ◆ **Crate Monitoring Board**

- Production Completed.
 - Installation completed

- ◆ **Low Voltage Power Supplies (next slides)**

- Production & Installation in Process

- ◆ **Integration in Experiment.**

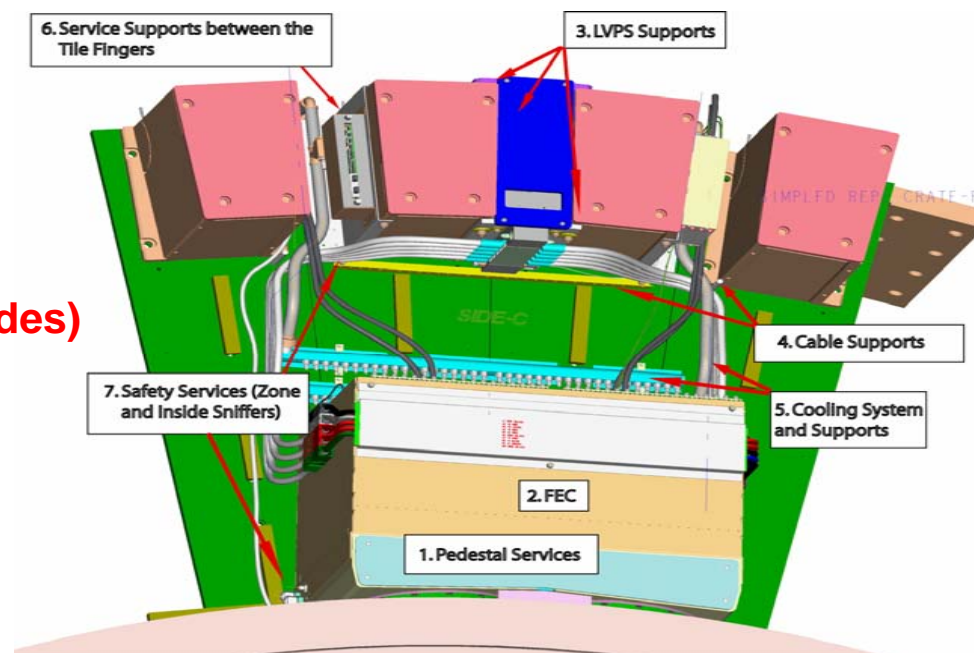
- Barrel Completed.
 - Endcap in progress

- ◆ **Detector Control System (DCS)**

- Temperature monitoring
 - FEC voltage monitoring
 - Power supply status and monitoring

- ◆ **Commissioning**

- Electronics In Progress
 - Cosmic Rays – on-going since Aug '06



Low Voltage Power Supplies(I)

- **Persons Responsible:** F. Lanni, J. Kierstead (Eng.)
- **Responsibility:** All LAr Front End Power Supplies.
- 58 PS on detector, 3.2 kW Power, 280VDC input
- Critical Space Limitations.
- High Reliability (N+1 Design)
- Contract signed with MDI in April '04.
- Several problems during the production
 - ◆ Weak components
 - ◆ Thermal problems
 - ◆ Poor contact in current return
 - ◆ Long term burn-in failure
- Production continued and finished, but
 - ◆ Delivery rate was slow, lots of rework
 - ◆ Only 14 currently installed on detector

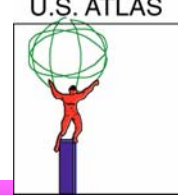
Open LVPS.

16x30x30 cm



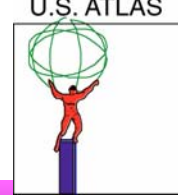
The LVPS as produced are not reliable for detector operation. A critical item.

Low Voltage Power Supplies (II)



- A new strategy has been defined and implemented (Oct 06)
 - ◆ Setup of a task-force for a complete circuit and failure analysis with the goal to define changes to be retrofitted on the LVPS modules and ultimately guarantee mid-term (~next 2 years) needs of LArg before a possible replacement may become available
 - ◆ Develop a concurrent new design plan for the long term
- Large-scale investigative effort at BNL:
 - ◆ Task-force : 6 EE, 3 Physicists, 1 PE, 1 ME Designer, 4 Techs
 - Contribution from other ATLAS LAr collaborations
 - Good support by BNL (Inst. and Magnet Div) and US-Atlas management
 - ◆ Full Reverse Engineering of the LVPS through an external company
 - ◆ External consultants (top-notch PS eng. firm)
 - Math modeling, SPICE simulation, failure analysis, WCA, FMECA and reliability prediction.
 - ◆ Redesign of parts to address all of the issues
 - ◆ Lots of findings in the last several months.
 - ◆ Analysis completed by end of Feb, 07.

Low Voltage Power Supplies (III)



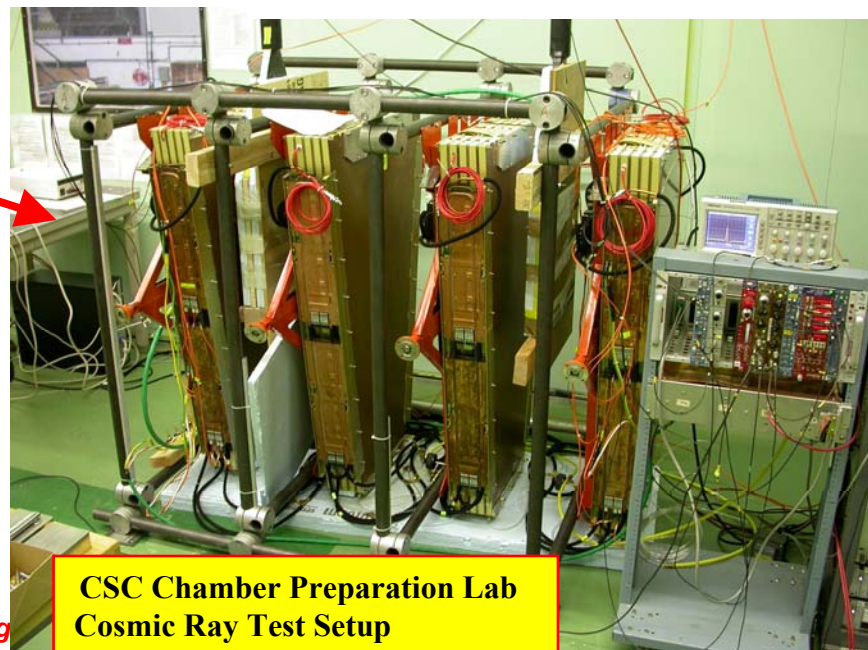
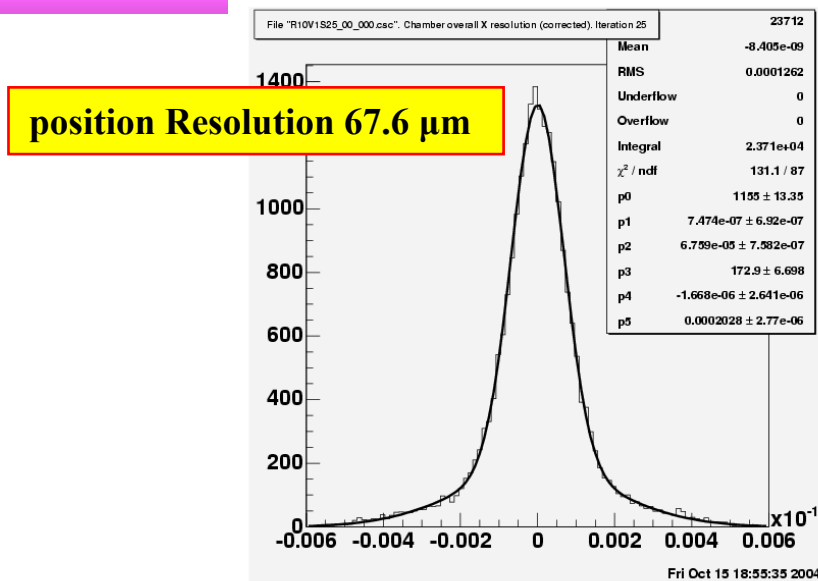
- The Task-force has evaluated each of the issues detected by the analysis and simulation
 - ◆ Troubleshooting of failed units confirmed mostly QA issues and a few wrong components
 - ◆ About 30 components/modules in each PS are being changed
 - 27 modules/unit ---> ~900 components to be changed in each unit
- A Source Selection Committee was set up end of Dec '06 to identify a potential Assembly House for retrofitting
 - ◆ The bidding phase has been completed early January
 - ◆ The selection process has been completed end of Jan.
 - ◆ references from recent past projects and field-visits
 - ◆ Contract has been awarded in Feb to Algen Design Services Inc.
- Intense rework campaign started in March (expected to finish in July)
 - ◆ First 2 completely retrofitted units extensively tested, and passed.
 - ◆ 4/week delivery, first lot shipped 4/12/07

Developing a concurrent new design plan

A new revision of the LAr LV Power Supply Specification has been drafted
Request for Proposal (end of Mar), Source-Selection Committee to evaluate
Plan to award first manufacturer by end of April 07

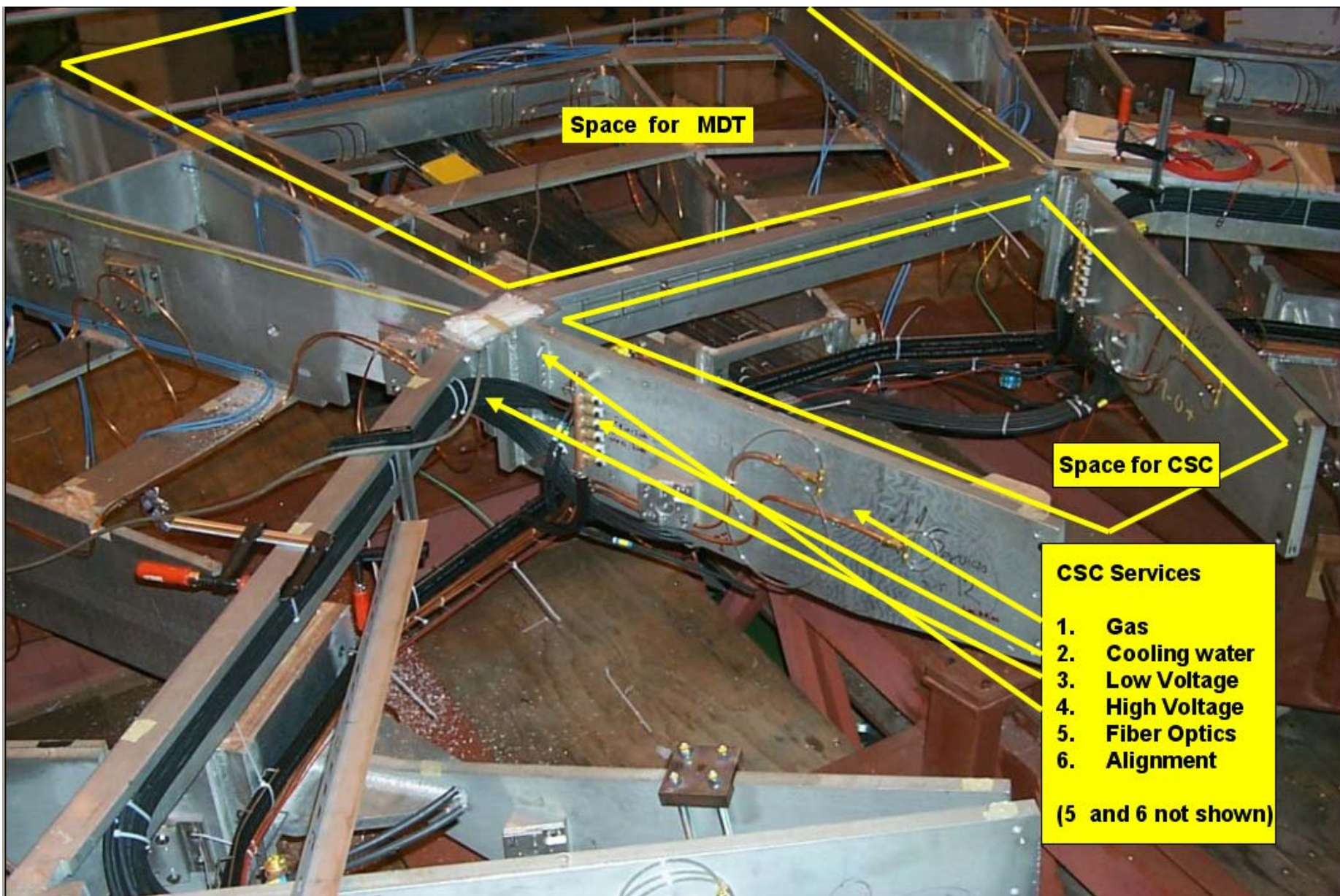
Cathode Strip Chamber Status

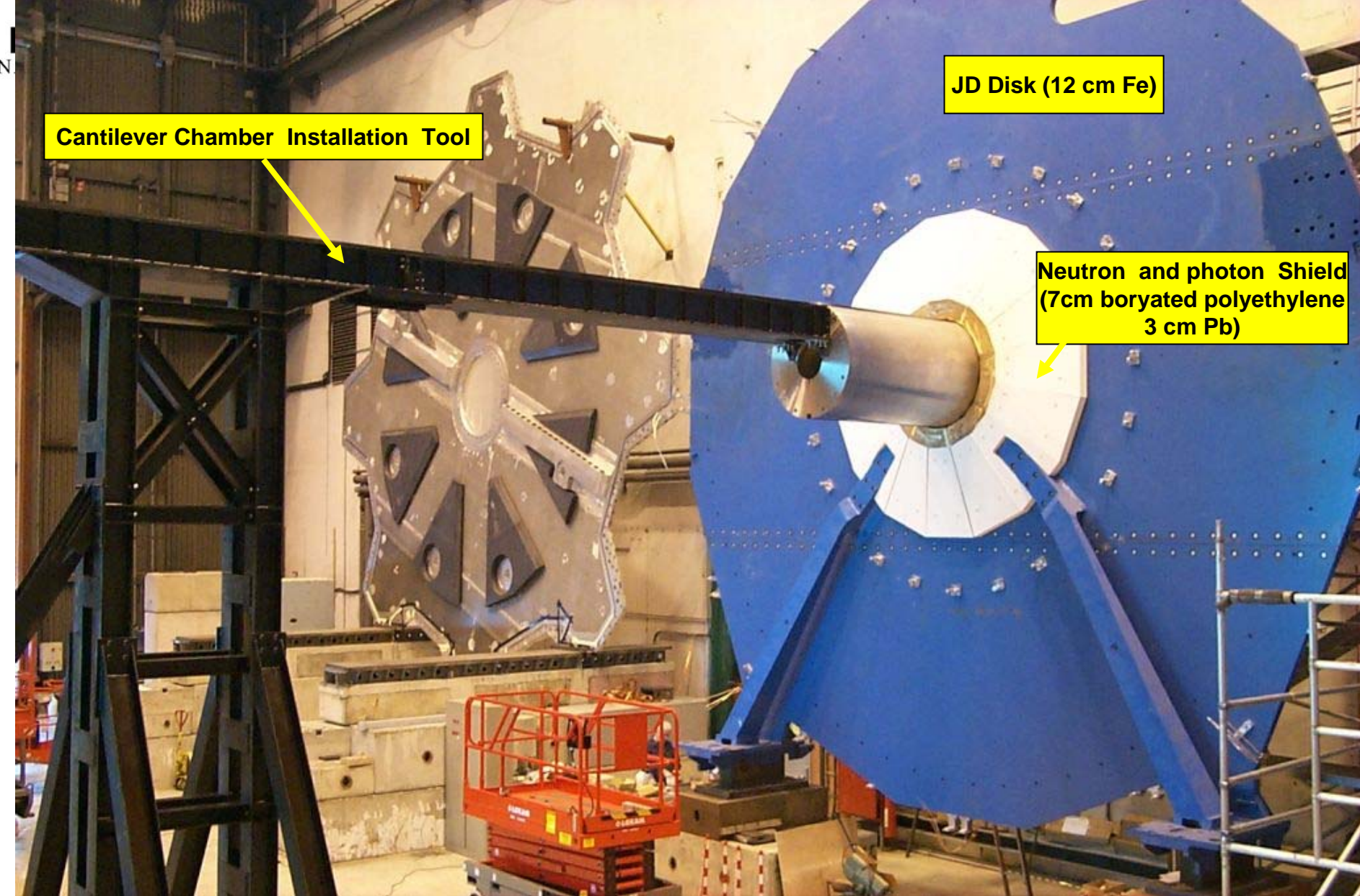
- BNL produced 32 CSC muon chambers
 - ◆ Precision chamber in high rate in high eta region.
 - ◆ V. Polychronakos, V. Tcherniatine
- All Chambers shipped to CERN.
- Chambers are thoroughly tested at lab with horizontal cosmic rays
 - ◆ natural orientation of the chambers.
- Chamber Integration into small wheel on-going at CERN.
 - ◆ Service connections



Installation of MDT and CSC Services

Wheel C in horizontal position





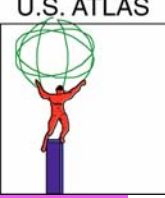
Cantilever Chamber Installation Tool

JD Disk (12 cm Fe)

Neutron and photon Shield
(7cm boryated polyethylene
3 cm Pb)

**Next Step: Small Wheel to be rotated into a Vertical position,
Chambers to be mounted and services connected and tested**

Technical Coordination

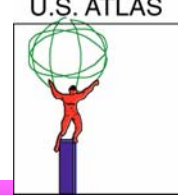


Persons responsible: D. Lissauer* , A. Gordeev, S. Duffin, J. Farrell

BNL Responsibility:

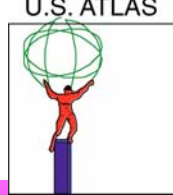
- *TC Activity A (Project Office) Manager
- *ATLAS Technical Management Board
- *ATLAS Upgrade Project Office Leader
- Configuration Control
- Placement in situ & Stability Monitoring
- Services Routing
- Access during installation & operation
- Coordinate and monitor upgrade R&D

Where are we (I)



- **ATLAS Schedule is synchronized with the machine.**
- **Infrastructure:**
 - ◆ **Infrastructure installation ~98% complete,**
 - ◆ **Cabling/Gas well advanced.**
- **Magnets System:**
 - ◆ **Solenoid Commissioned ready for operation.**
 - ◆ **Barrel Toroid Commissioned ready for operation.**
 - ◆ **ECT . critical path. Integration under way, Installation time.**
- **Calorimeters**
 - ◆ **Barrel Calorimeter - Partially operating for cosmic Ray**
 - ◆ **EC calorimeters . being cooled down (or ready for cool down)**
 - ◆ **Power supplies issues, LV (LAr) needs to be resolved.**
- **Inner Detectors**
 - ◆ **SCT/TRT Barrel installation done.**
Connection and commissioning on going.
 - ◆ **EC installation by early 07.**
 - ◆ **Pixel on Critical path . Cables, Modules.**

Where we are (II)



- **Muons:**

- ◆ Barrel Muon chambers: installation >95% complete, being commissioned.
- ◆ Big Wheel assembly on Side C in progress, rate satisfactory.
- ◆ Small Wheel integration started.- Critical Path

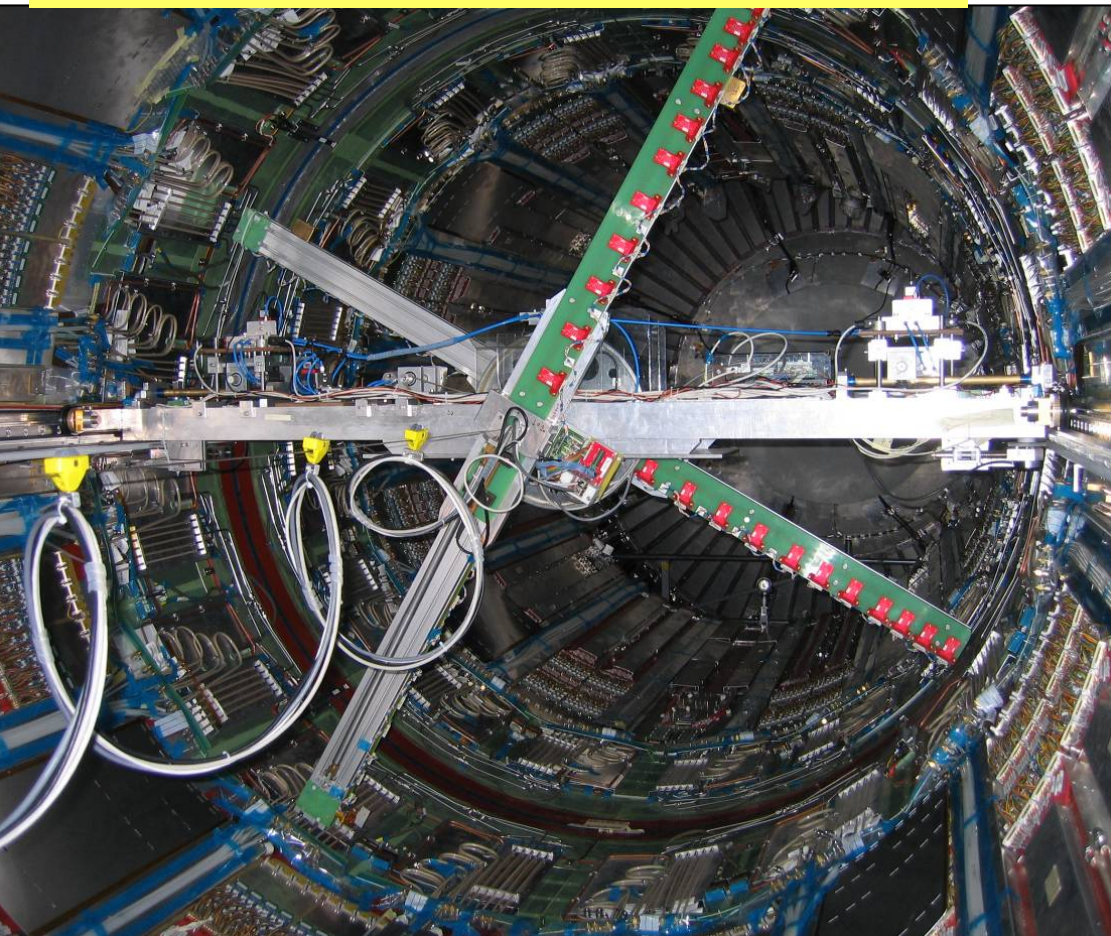
- **Counting rooms & control room:**

- ◆ Installation of readout electronics well underway.
- ◆ High Level Trigger and DAQ commissioning started. .
- ◆ Data Taking mode to start Spring '07 (Cosmic Rays)

- **Run Organization & Preparation:**

- ◆ Control room (main and some satellites) started operation.
- ◆ Cosmic muon data, calibration stand-alone and combined on-going.
- ◆ Large number of people will be needed @ CERN full time.

Field mapping machine in the Cryostat bore



250,000 points measured (for 4 different current values)
Error of 10 Gauss
Field Knowledge to better than 10 Gauss

July – August 2006:

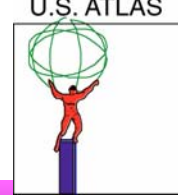
The solenoid has been fully commissioned *in-situ* up to 8.0 kA

The operation current is 7.73 kA for a field of 2.0 T

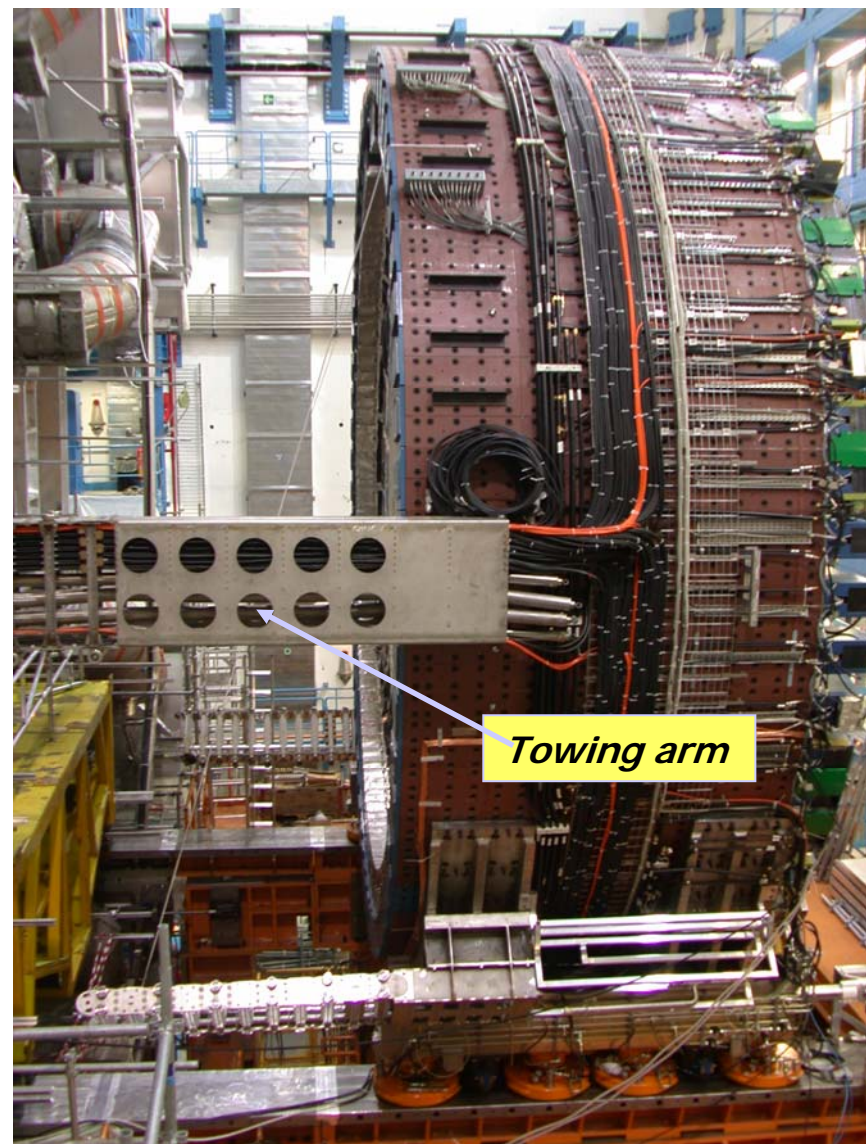
1st August 2006:
the solenoid is fully operational



Opening of Endcap-A

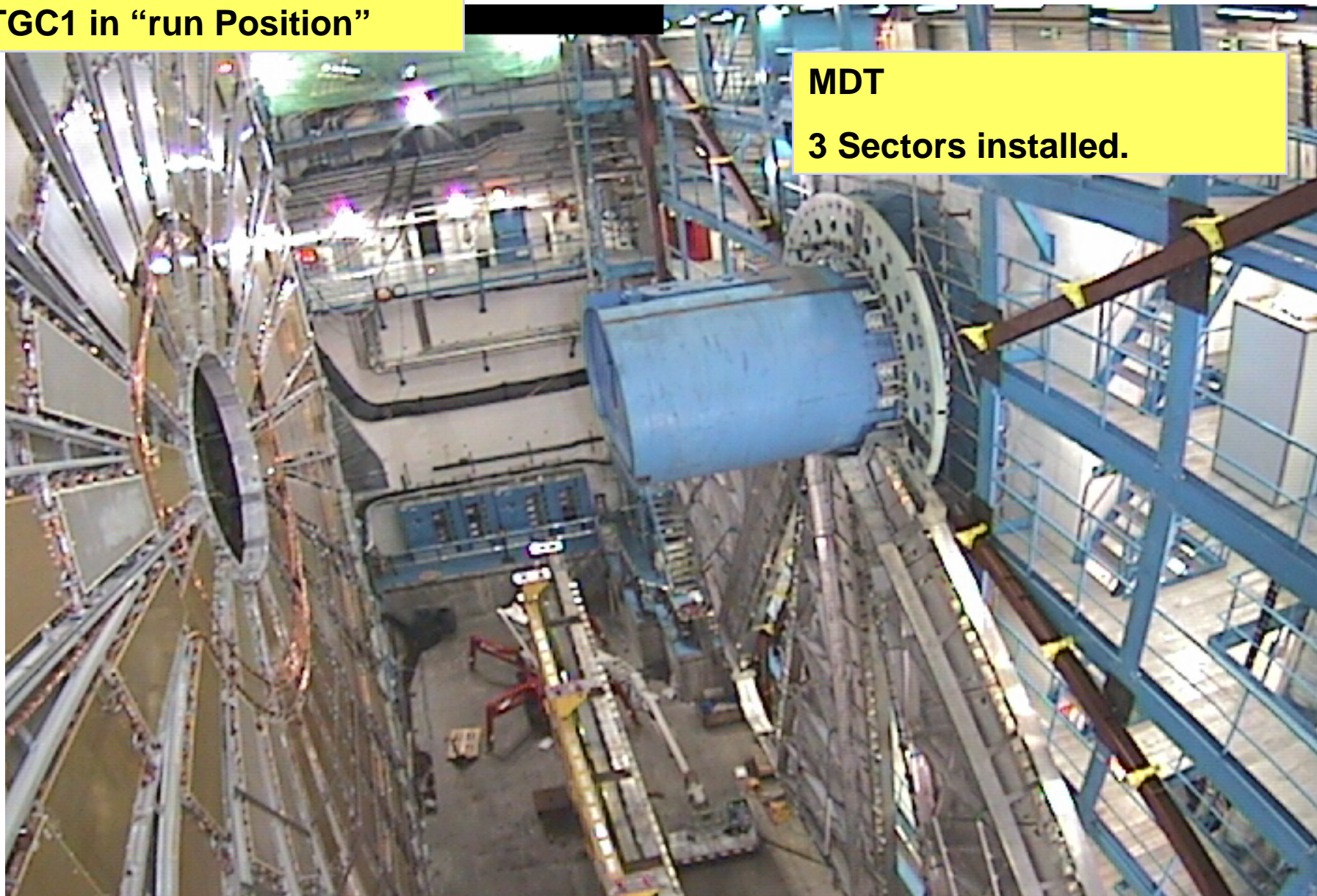


**Cable Schleps for Calorimeters EC
were installed and commissioned in
'06.**



MDT Wheel started

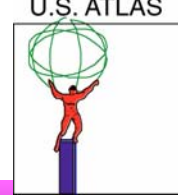
TGC1 in “run Position”



MDT

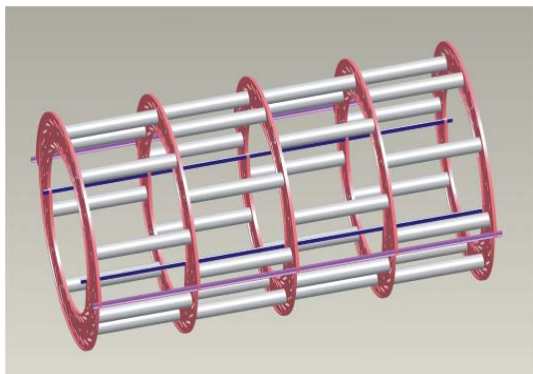
3 Sectors installed.

ATLAS upgrade R & D

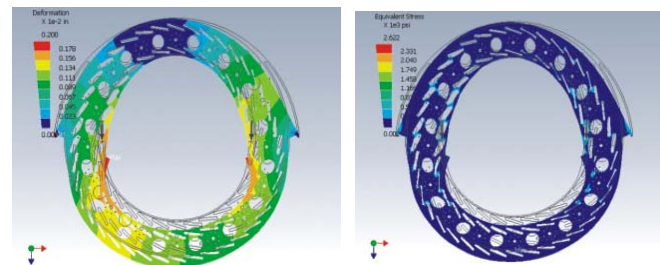


- Consider LHC Luminosity upgrade scenario
 - ◆ SLHC : $L = 10^{35} / \text{cm}^2 / \text{s}$
 - ◆ Bunch crossing: $25\text{ns} \rightarrow 12.5\text{ns}$
 - ◆ No. interactions/Crossing: $20 \rightarrow 100$
 - ◆ Radiation: X10
 - ◆ Rates: X10
 - ATLAS upgrade R & D
 - ◆ New Si Tracker (strawman defined)
 - ◆ Muon trigger, additional cathode strip chambers
 - ◆ Calorimeter electronics, forward calorimeter
 - BNL Involvements
 - ◆ D. Lissauer is the ATLAS Upgrade Project Office leader
 - ◆ F. Lanni is the LAr Calorimeter upgrade co-coordinator
 - Electronics R&D in Collaboration with Columbia, SMU, StonyBrook, Pittsburgh, UPenn,
 - ◆ Silicon Tracker: D. Lynn, H.Chen, S.Recia*, J.Kierstead*, Z.Li*
 - Short strip development*
 - digital readout tests
 - Barrel structure studies
 - ◆ Cathode Strip Chamber production (Polychronakos, A Kandasamy*)
- * Instrumentation Division

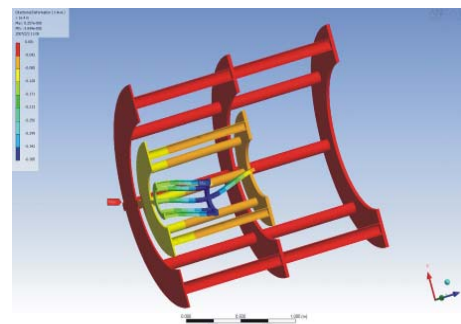
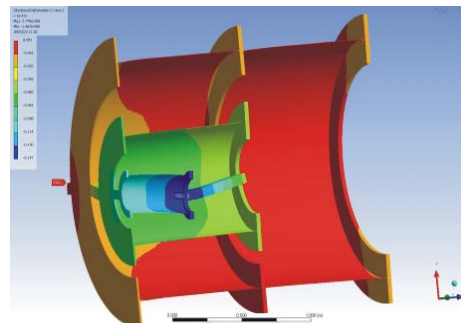
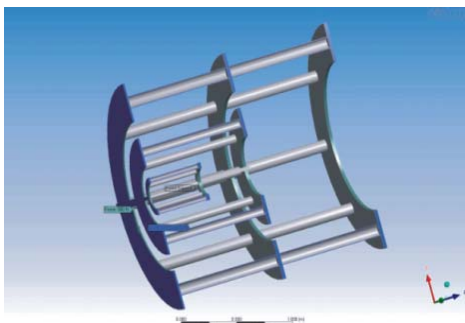
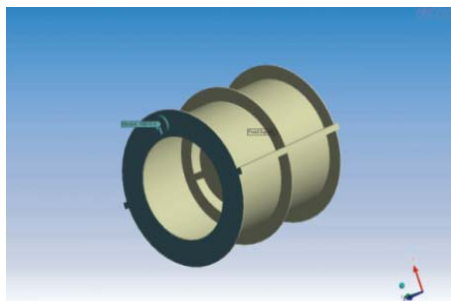
“Open” Space Frame First Proposed



Flange Simulations Below Show Minimal Deflection/Stress



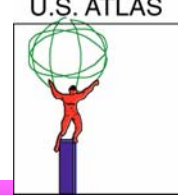
Concerns about stiffness suggest we study “Closed” space frame approach vs. open space frame



Frequency analysis indicates similar frequency response between open and closed (shown on left)

Early simulations show greatest difference is between approaches is in terms of torsion– not yet clear how important

Summary



- Detector construction at BNL is being completed.
 - ◆ LVPS is being retrofitted under M & O
- Present effort concentrate on installation and commissioning
 - ◆ detector components (LAr, Muon, Trigger)
 - ◆ Technical Coordination.
- ATLAS upgrade R & D for SLHC upgrade underway.
BNL has Significant responsibilities in:
 - ◆ New ATLAS tracker, LAr readout, Upgrade project office
- These efforts complement well and are coordinated with the ongoing physics analysis efforts.
 - ◆ Remaining committed to detector operation and R&D while strengthening our physics analysis effort requires additional manpower.